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THE

AGRICULTURAL LEDGER.

1895—No. 9.

AL DYE—MORINDA.

[*DICTIONARY OF ECONOMIC PRODUCTS, Vol. V., Pt. I., M. 651–716.*]

n *Enquiry into the present condition of the Al-dyers and of the growers of Al-root: also some remarks on the origin of the form of* Morinda *known to botanists as* M. tinctoria; *together with an account of a new and simple process of utilizing the Al-dye,—by* THE EDITOR.

Other DICTIONARY articles that may be consulted :

Bixa Orellana, *Vol. I.*, B. 533.
Cordia Myxa, *Vol. II.*, C. 1933.
Curcuma longa, *Vol. II.*, C. 2477.
Ricinus communis, *Vol. VI., Pt. I.*, R. 371.
Symplocos racemosa, *Vol. VI., Pt. III.*, S. 3064.
Symplocos theæfolia, *Vol. VI., Pt. III.*, S. 3077.
Terminalia Chebulia, *Vol. VI., Pt. IV.*, T. 329.
Woodfordia floribunda, *Vol. VI., Pt. IV.*, W. 108.

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E. C. BUCK,

Secretary to the Government of India.

(Vegetable Product Series, No. 16.)

THE

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AL DYE—VARIOUS FORMS OF MORINDA.

[*Dictionary of Economic Products, Vol. V.*, **M. 651—716.**]

An Enquiry into the present condition of the Al-dyers and of the growers of Al-root: also some remarks on the origin of the form of Morinda known to botanists as M. tinctoria; together with an account of a new and simple process of utilizing the Al-dye,—by THE EDITOR.

Botanical considerations essential.

The specific name **tinctoria** having been assigned by Roxburgh to one of the forms of **Morinda**, many popular writers (and very naturally so) have presumed that the cultivated dye-yielding plant was **M. tinctoria.** But it transpired subsequent to the publication of Roxburgh's work that the chief source of the dye was a species named previously by Linnæus as **M. citrifolia.** Any species of **Morinda** may, however, afford the dye but in varying propoltions, higher in the cultivated forms than in the wild. This circumstance has rendered it necessary that in every attempt that may be made to advance the interest concerned in *Al* dye the very greatest care and attention should, for some time to come, be paid to botanical considerations. It would obviously result in disappointment and failure were carefully selected specimens to be sent to the chemist, but the practical dyer furnished subsequently with inferior **Morinda**—supplied in fact with roots that afford a very much smaller amount of dye than those examined by the chemist. In the experiments hitherto performed in Europe it has frequently happened that the practical dyer's results have to all intents and purposes discredited the chemical investigations. This has been due to either of two circumstances—(*a*) ignorance in Europe of the method necessary to obtain the red dye from the roots, and (*b*) ignorance in India of the fact that there are various forms of **Morinda**, and, therefore, various qualities of the roots, some of which may contain little or none of the red, for which the roots are valued.

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Failure in extracting the dye.

Conf. with p. 20.

As an example of the former reason of failure, mention may be made of the circumstance that **Mr. Thomas Wardle** of Leek, one of the most enlightened and experienced of dyers, failed absolutely to discover the red dye in an extensive series of samples of *al*-roots sent to him for experiment. He was of opinion that the Natives of India must use *manjit* **(Rubia)** along with their *al*, and consequently was led to affirm that the former must in that case be regarded as the source of the red colour. But on his visiting India **Mr. Wardle** obtained abundant evidence that the *al* roots do actually yield excellent reds, and his subsequent experiments abundantly confirmed the Indian experience.

Future of Al-dyeing industry.

Conf. with pp. 19-20.

Since the date of publication of the Dictionary, large commercial samples of some of the chief kinds of *al* roots have been furnished by the Government of India to the Imperial Institute, London. These have been subjected to careful chemical examination by **Professor Hummel** and **Mr. Perkin** of the York College, Leeds. The result has been that these chemists have published a scientific explanation of the principle involved in the isolation of the red dye. The possibility, therefore, of a trade with Europe in **Morinda** dye has been advanced very materially. No dyer need now fail to obtain the red principle, and the development in the future of a large **Morinda** industry may accordingly be said to turn on certain Indian considerations such as :—First, whether it will pay to cultivate the *al* root as an article of foreign export ; second, for Indian investigators to discover which species and what forms of that species afford the greatest amount of dye, and are, therefore, the plants that should be cultivated ; third, to ascertain whether the yield of dye from the more prevalent wild species is sufficient to justify the attempt being made to create a trade in this as an article of forest produce ; fourth, to find out the area over which **Morinda** cultivation could be profitably extended, keeping in view of course the influences of climate and soil on yield of dye, as also the facility of transport to the seaboard.

Prospects of a foreign market.

Were it possible to organise a foreign trade, an incalculable boon would be conferred upon a class of cultivators, who through the extension of the use of aniline dyes may be said to have been ruined. The Indian trade in *al* dye having been practically exterminated within the past few years, it becomes a matter of the greatest importance to India to definitely ascertain the prospects of a foreign market for the root.

The botanist and chemist to aid each other.

While, therefore, the chief responsibility of future developments rests for the present upon India, the aid of the chemist cannot be said to be unnecessary. There are, as it seems to the writer, at least two directions in which the contemporaneous researches of the chemist are indispensable. Indian officials must see that they collect certain well-known roots, not as in the past, bazar or commercial samples. These will have to be accompanied with carefully preserved botanical specimens, so that the botanist may be able to furnish the chemist with the racial or specific names of the plants under his investigation. By this means it would be possible to discover the varying yields of

dye in different species, varieties, or races, both of the wild and of the cultivated plants, as also of the influences of environment on these forms. The co-operation of the chemist in this enquiry is essential, but he can render an even greater service. Past experience in Tea, Indigo, Jute, Cotton, Silk, etc., has abundantly shown that if an Indian industry is to be greatly expanded it must enlist European capital and enterprise. Remarkably few Indian industries that have remained in the hands of the Natives during, say, the past half century of India's commercial development have made any tangible progress. This is doubtless largely due to the ignorance of the people of India in the principles by which alone large and prosperous undertakings are controlled. In their agriculture they are peasant farmers, and in their manufactures they are village artizans. With both these classes it is only too frequently the case that the governing principle is immediate gain, and hence adulteration is often exalted into a science, instead of being viewed as an absolute barrier to greatly extended dealings. If, therefore, **Morinda** has any chance of being raised from the position it at present holds into that of one of India's commercial products, it would almost seem as if the chemist would have to discover a process by which a profitable enterprise might be organized in the preparation in India of a dye-stuff, somewhat similar to indigo, which could be exported in a condition ready for immediate use. This, it will be seen below, has practically been discovered by **Hummel** and **Perkin**, for these distinguished chemists may be said to have not only removed the chief difficulties hitherto experienced by European dyers in the utilization of *al*, but laid the foundation of further possible developments in the direction indicated. In India it has not as yet been found remunerative (with few exceptions, such as Tea, Coffee and Indigo) for European capital to be directed to purely agricultural undertakings. Unless, therefore, some opening be afforded for European enterprise, to pioneer the new industry, it is hardly to be expected that much progress would be made even by half a century of continued demand from Europe, for the supply of roots of a uniform quality.

European enterprise necessary.

Prepared dye needed for export.

But in concluding these introductory remarks, it may be said there is still a third direction in which the chemist may aid the Indian investigator. The opinion is very generally held in this country, and has been so for centuries, that cloth dyed with *al* is proof against the ravages of white ants and other destructive insects. This belief is alluded to in the Dictionary (page 265) as the reason why *khárua* cloth is so universally employed by the Native bankers and shopkeepers to wrap around their account books. In many parts of India the ravages of white ants are so great that they may be said to destroy the avenues of trees planted along the roads near towns and villages. But in some parts of the country the stems are often painted round and round for, say, two feet from the ground upwards with a preparation consisting in some cases of the refuse of the *al* dye works, in combination with garlic and other such ingredients. This is said to check most completely the ravages of white ants.

Insecticide properties of the dye.

Preservation of trees in Gondal State from white-ants.

PAINT USED AGAINST WHITE-ANTS.

During a brief visit to the Native State of Gondal, the writer recently gave this subject considerable attention. There seemed to be no doubt that His Highness the Takore Sahib, by his enlightened action in this matter, had effected a radical improvement. The trees throughout his State were all painted as described, and not a single tree could be found showing the mud encasements so characteristic of the presence of white-ants. And very possibly, as a consequence of the care bestowed on these trees, they were healthy and vigorous, while those in neighbouring States were sickly and badly attacked with white-ants. In consequence of these observations the writer asked for information as to the composition of the paint which had been used. He was informed that the red colour was merely to indicate the fact that the trees had been painted, and that it was for the most part red ochre. The useful ingredients were said to be as follows:—

Paint used for white-ants.

1 part *dekamali* gum (the resin of **Gardenia gummifera**).
2 parts asafœtida.
2 parts bazar aloes.
2 parts castor-oil cake.

These are well pounded, mixed and kept in water for about a fortnight. When thoroughly united and, what may be called decomposed, into a thickened compound, water is added in order to bring to the consistency of paint and the colouring matter then added. The mixture is now ready for use, and if thoroughly applied for about two feet will check not only the attacks of white-ants, but of red ants and other insect pests. Its effect will last for two years or more. The cost of the preparation comes to about 4 to 5 rupees per 100 trees. But according to the information furnished from Gondal, *al* refuse possesses no special properties; from other parts of India the reputation is very general that it is of great value. The red ochre, added to the above preparation, may not only be useful as indicating the trees that have been painted, but give a useful consistency, if it does not serve to mechanically hold the other ingredients.

Ochre: *Conf. with p. 15.*

It would, however, seem desirable to have the reputation of *al* as a preventative against the attacks of insects thoroughly investigated, even supposing it be admitted that experience in Gondal has proved that it is of no very special merit as a paint on trees. The system of painting trees (as detailed above) might with great advantage be extended throughout India, especially in orchards; and it is even probable that the Tea and Coffee planters might find the system of great value in checking the depredations of insect pests. But there remains the main issue, the importance of this reputed property of *al* dye being thoroughly investigated. If it be actually a fact that it preserves the textiles so dyed from being attacked by insects, that would be a powerful reason for its greatly extended use in all cases where lasting properties were essential. The writer would wish it to be distinctly understood, however, that in dealing with the subject of

Useful to Tea-planters.

Insecticide properties of Al require investigation.

the preventative power of *al* against white-ants, he desires to give greater currency merely to a very generally accepted Native opinion, and one which has not as yet been either confirmed or disproved by scientific investigation.

Origin of **M. tinctoria** from **M. citrifolia.**

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It may be of interest to record here some observations made by the writer during a recent tour of inspection through certain of the *al*-producing districts of the Central Provinces and of the Berars, since these would seem to point to a possible error in the botanical literature of the dye-yielding species of **Morinda**. Being familiar, from previous study of dried herbarium specimens of that genus, that grave doubts might be entertained as to the desirability of retaining Roxburgh's **M. tinctoria** as a species distinct from **M. citrifolia,** he was prepared when opportunity afforded to examine critically the various forms met with in cultivation. It may best elucidate the facts discovered by dealing with them categorically.

Al grove at Sauner.

Near the village of Sauner, in the Nagpur Districts, a grove of **Morinda** trees was met with in the corner of a large field. The cultivators explained that these were from 30 to 50 years old; they were about 40 feet in height. These trees were said to have been formerly employed in furnishing seed for a crop known as the *moti* (larger) *al*, and ordinarily fetched about R60 per 400lb of ripe fruits. The trees flower in June and were in nearly ripe fruit on the 1st of December. When asked when the fruits would be collected, the cultivators replied that there was now no demand for the seed and hence the trees were useless.

See Plate 1.

It may be here remarked that the lower branches of these trees bore large ovate-oblong leaves, 6 to 9 inches long, and 3 to 5 inches broad, sometimes almost cordate, and with a suddenly cuneate prolongation on the petiole; while the upper branches had much narrower, almost linear-oblong leaves, and were for the most part softly tomentose. Indeed the twigs plucked from off the same individual plant practically manifested the difference in the foliage of **M. citrifolia** (the old large bluish-green shining leaves) and **M. tinctoria** (the narrower pale-green and tomentose leaves). The young twigs were square, pale-green, hairy, with large pointed bifid stipules, the old twigs were cinnamon-brown, with broad rounded entire stipules. The inflorescence was lateral and opposite a leaf in the old twigs, and more or less terminal in the young. Indeed the contrast between specimens from the lower and older parts of the tree and from the upper and younger was so great that if dried separately they could hardly escape being regarded as representing well-marked varieties, if not distinct species. The specimens collected at Sauner were numbered 13820, but subsequently other samples were procured from trees and the above peculiarities repeatedly verified. Of this nature may be mentioned the trees found at Surla (Specimens No. 13822), at Bailona (No. 13866), and at Ashti (No. 10502).

While examining these trees the complaint was made by the

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cultivators, far and near, that they had been deprived of one of their most remunerative industries—the cultivation of the *al*. They pointed to the neglected trees by the sides of the fields and to the plants of *al* that now spring up all over the fields as useless and troublesome weeds. In only one or two localities were actual fields of *al* cultivation to be found. Near Surla, for example, a few fields were inspected. These had been sown broad-cast in June, and the plants were in December about 5 to 10 inches in height. As these possessed long narrow leaves, very hairy and pale-green, they were at once thought to be **M. tinctoria,** *Roxb.* Since they were not in flower the cultivators were asked if they could show any older plants of this same form—the *moti al* as it was called. They pointed to some trees at a little distance as those from which the actual seed for these fields had been obtained. After collecting specimens of the field crop (No. 13821) we marched off to inspect the trees and found these (No. 13822) identical with the Sanner trees already described. On expressing doubt as to the field plant having been produced from these trees, because, while the trees had large broad sub-glabrous leaves, the field crop had narrow hairy ones, the cultivators laughed and drew attention to the fact that the self-sown seedlings underneath the trees manifested every possible gradation in foliage. They were then asked the question "if seed from these trees produce the *moti al*, from what source is the crop known as the *chhoti al* obtained"? The answer received was that it is the same plant under different treatment. Fields of *chhoti al* were then inspected, when the plants were found scarcely, if at all, distinguishable from certain *moti al* seen in the fields close by. The *chhoti al* was, as it happened, in a further state of growth than the *moti al*, owing to the crop having been collected, and only the older plants left for seed purposes were therefore to be seen, whereas the *moti al* was in the state of seedlings in their first year of growth. The former were in flower, the latter not; but on the roadsides we were shown *moti al* in flower, and these plants were said to manifest absolutely the appearance of the cultivated *moti al* in its second and third years. The *moti al* was observed to be a more robust plant, the seedlings being even more woody than the mature *chhoti al*. The leaves are thicker, more hairy, much longer and at the same time comparatively narrower than in the *chhoti al* plant. The latter has also a strong tendency to produce procumbent or deflexed and arched branches, a peculiarity probably the result of their less woody structure in relation to the weight of fruit that they have to carry.

The Moti Al and the Chhoti Al, see Plate 2.

Origin of Chhoti Al.

In several localities one and the same explanation was given of the origin of the *chhoti al* crop, which may be briefly stated. If seed from the large wayside trees be collected and sown, that will produce *moti al*, a form that will only mature its dye-yielding roots (in paying quantity) after the third to fifth year. Many of the *moti al* plants may, however, be seen to flower in the second or third year and so continue in flower very nearly throughout their subsequent growth, ripening fruit in December. If from these plants seed be collected and sown the *chhoti al* is obtained—a plant that may produce its flowers

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and fruits in twelve months. It, moreover, yields a rich crop of the finest of all roots in 14 to 20 months from the date of being sown. The cultivators admitted, however, that they rarely take the *moti al* seed to sow for a *chhoti al* crop, but prefer to allow a few plants of the *chhoti al* field to ripen seeds for next year's sewings. There has thus been developed a special annual or biennial cultivated race or stock that can hardly be said to possess structural peculiarities, but rather which exists under certain methods of treatment. It would thus seem that by a process of selection, and as the result of centuries of cultivation, the *al* growers have produced from a perennial tree an annual, or at most biennial, field crop. They have altered the nature of the plant by reducing it from a tree 40 feet in height to a bush 6 inches to 2 feet in height. Have made it fruit as a biennial and flower not in June only, as in the case of the trees, but from June to December. They have caused it to produce thin roots with thick dye-yielding bark and little or no wood. In trade the roots are assorted into three qualities according to size, but the whole of the *chhoti al* crop would be referred to the finest of all qualities, the thinner roots of the *moti al* being at most only adulterants for the *chhoti al*.

These are remarkable, though not of course unparalleled, results, but it is very unfortunate that the accumulation of centuries of knowledge should now be in imminent danger of being entirely lost, since the crop is everywhere being abandoned and the annual and biennial stock neglected as a weed which will rapidly revert to its perennial and less valuable condition.

Specimen collected.

The specimens collected in the fields were as follows:—Nos. 13821 (*moti al*, seed from the trees 13822) and 13823 (*moti al*, a weed in fields); 13824 and 13825 (*chhoti al*, old plants left for purposes of seed; and 10517 (*moti al* found in fields as a weed of cultivation).

Different forms of the plant.

These field plants have all got the narrow leaves characteristic of **M. tinctoria,** *Roxb.*; while the tree form, as already detailed, corresponds as near as possible to **M. citrifolia,** *Linn.*

It was also observed that shoots springing from the roots of old plants had very thick hairy leaves (Nos. 13822A and 10502), that answer admirably to **M. tomentosa,** and that here and there among neglected plants many flowers had protruding stamens, thus showing that the so-called species—**M. exserta**—must be regarded as a mere sexual state. In this connection it may be remarked that Mr. J. F. Duthie, (*Field and Garden Crops* of the North-Western Provinces, Vol. III, pp. 55-57, pl. 89) figures and describes a form with protruding stamens as the *al* plant of Bundelkhand. Commenting on this subject, he remarks: "**M. tinctoria** is by some botanists supposed to be the wild state of **M. citrifolia,** but as a species it may be distinguished by its smaller non-shining leaves. It seems probable both species are employed in the extraction of the characteristic dye." According to the observations detailed above, however, the arborescent form, **M. citrifolia** of botanists, should rather be spoken of as the wild state of **M. tinctoria;** and further, the more highly cultivated condition—the *chhoti al*—of the Central Provinces and of the Berars shows, if anything, a closer approximation to the condition of the foliage of the

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arborescent plant than do the seedlings derived direct from the trees themselves; it thus manifests long cultivation and the effort to recover the specific character of the original.

The inflorescence in the field crop is usually lateral, but in some cases, as on the long terminal branches of young trees, the heads of flowers become crowded together and produce the condition figured by Roxburgh as **M. multiflora.**

Different forms should be all reduced to M. citrifolia.

So far as the writer is concerned, therefore, he has satisfied himself that the varieties of **M. citrifolia** and of **M. tinctoria** (as described in the Flora of British India) can be no longer upheld, but that those two so-called species must be reduced to one very protean form—**M. citrifolia,** *Linn.* It is impossible to retain any of the conditions enumerated above as even racial states. The plant sports so freely that from the same individual root it would not be difficult to cut typical examples of **M. citrifolia, M. tinctoria, M. tomentosa, M. exserta, M. bracteata,** and even **M. multiflora.** The character of having bracts outside the fruiting head was not observed during the writer's explorations in the Central Provinces, but that character is so unimportant that after witnessing other sports it would not be difficult to believe that a few hours' longer search would have discovered fields of bracteated heads. The many-flowered character of **M. multiflora** was found plentiful in neglected plants (No. 13823) which spring up here and there through *Tur* (**Cajanus**) and other tall crops, the branches being elongated and the flowers produced at the extremities, as an adaptation to the conditions of life in a crowded field. It is somewhat remarkable that Roxburgh should have described **M. multiflora** as the peculiar form met with in Nagpur and Berar, at the beginning of this century. It very nearly follows from that remark that the whole of the **Morinda** specimens collected by the writer are forms of **M. multiflora,** or that that species is no longer cultivated in the Central Provinces. The majority of the plants seen at the present day do not possess the peculiar inflorescence that gave origin to the name of **M. multiflora,** so that the specific description would have to be greatly modified until in fact it merged into the protean **M. citrifolia.** Roxburgh's manuscript figure, however, of **M. multiflora** looks a great deal more distinct from the arborescent **M. citrifolia** than do **M. tinctoria, M. bracteata,** or **M. exserta.** But were a selection of sports figured, it would be possible to almost indefinitely multiply the species of this genus. It is, however, curiously interesting to find how completely Roxburgh's brief description of the Nagpur plant corresponds with the *chhoti* (lesser) *al* of the present day. He obtained the seed of it in 1801, and "by the close of the same year the plants were in blossom, and in one year more they have grown to large ramous shrubs, and now in eight years they are small trees and in constant flower. I may further remark that notwithstanding all the other four species of **Morinda,** already described and figured by me, grow to be small trees, they generally blossom the first year of their growth if the soil is good and the plants taken good care of." Roxburgh then concludes his ac-

Roxburgh's description.

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count of **M. multiflora** in these words: "This plant is cultivated about Nagpur as the other species are in various other parts of India and for the same purpose." The remark as to flowering will be seen to confirm the observations made by the writer in connection with the *chhoti* and *moti al* field plants. It is thus probable that Roxburgh had been supplied with seed of the cultivated races of plants, not the trees. The cultivators' strongest argument that the *chhoti al* is distinct from the tree form (where that opinion prevails) is generally that, while the tree flowers in June the field plant flowers throughout the year. That statement was repeatedly confirmed by the writer and will be seen corroborated by the fact that the specimens of the field plant (collected in December) are in flower as well as ripe fruit.

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CHARACTER OF THE CULTIVATION AND PRESENT POSITION OF THE "AL" INDUSTRY.

Al cultivation on the decline.

It has already been briefly indicated that the *al* industry of the Central Provinces and of the Berars is in a state of rapid decay. Some few years ago *al* cultivation was not only one of the most popular but most profitable of undertakings. Many large towns might be mentioned as having derived their entire wealth from some part of the trade. These are rapidly falling into ruin and the distress experienced is of course being felt more keenly by the labourers than by the better class members of the community. The introduction of aniline dyes (which have entirely superseded *al*) may in perfect fairness be described as little short of a calamity. It has reduced to the verge of starvation the inhabitants of large tracts of country and destroyed the artistic instincts of the people over a still wider area. While discussing this subject in company with a large circle of cultivators at Anjangaon and several other towns, a series of questions were put, to which the following (among other answers) were given:—

Answers given by cultivators.

1. Cultivation has been entirely discontinued within the past four or five years.

2. Formerly 6 per cent. of the cultivation of Anjangaon was devoted to *al*, and at Pathrot (6 miles off) there used formerly to be as much as 12 per cent.

3. It was a very profitable crop. If four acres were under cotton the yield might come to R60, but *al* would give R150 or more, for each of the years that the crop occupied the soil.

4. The cultivation was so profitable that the *al* districts were very prosperous. Now the complaint was universal that they were suffering very greatly through the loss of their industry.

5. *Al*, after the first year, was not affected any way by superabundance or insufficiency of rain. The crop in fact gave no anxiety.

6. During the last year of cultivation the demand had so declined that the cultivators gave the produce for nothing to any person who would dig it up and remove it.

7. The seed was procured from the field crop, not taken from the trees, but it was admitted this was more from convenience than necessity. They accounted for the existence of rows of trees by supposing them to have grown by accident. In other villages the trees

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Answers given by cultivators.

were said to afford the seed for the *moti al* crop, but in Anjangaon the *chhoti al* crop only was grown.

8. The seed was specially prepared. On the fruits being collected they were piled in a heap till they had turned black and the pulp softened. This was accomplished in three or four days. After roughly separating the seeds by breaking them on stones or by means of the *mogra* (mallet) they were again piled together for fifteen days. The seeds were then placed in baskets and sunk in the river, by which process the pulp was washed away. After this the seeds were spread out to dry. The seeds of the *chhoti al* are smaller than those of the *motial*.

9. About 20 seers an acre were used and they were drill sown, as in *jowari* or cotton, the drills being 4 inches apart.

10. The soil was prepared as for other crops. It was ploughed three times, cleared of weeds and sown in June. The plants appeared about a month later. During the first year the weeds were removed about four times, but the *al* was never thinned out. No further treatment was necessary.

11. Cattle are, however, fond of the plant, so that during the first year the field had to be watched. If seed were required the plants had to be watched the second year also, not otherwise. But the crop was subject to no diseases. If rain did not come in time the seed would remain in the ground and germinate when the rain did come.

12. It often flowered and fruited the first year and would continue to do so during its second or even third year.

13. In Anjangaon the crop was usually gathered in the third year, but it took no harm and could be collected when it suited the cultivator's convenience in the second, third, or even fourth year. It was usually dug up somewhere in November to January, but lazy cultivators even delayed the collection of the roots till March. The roots usually penetrate to a depth of 3 to 4 feet according to the character of the soil.

14. Sandy soils were best suited to the crop: black soils were too hard and the roots could not penetrate sufficiently and were removed with difficulty. The straight roots were regarded as the best, and distorted roots from heavy soils the least valuable.

15. The objection to the biennial crop was the lesser yield. The Anjangaon cultivators held that the *chhoti al* three years old was by far the best.

16. It was supposed to be an exhausting crop, but chiefly because the ground was dug to such a depth that unfertile soil was brought to the surface. It was accordingly customary to leave the field fallow for a year, and in that case it was found that the field had been greatly improved by *al* cultivation.

17. After the roots were dug up they were separated from the stems and at once cut into small pieces. The men who dug up the roots were paid at the rate of 8 annas per maund, and those who cut and assorted the roots according to size got daily wages. The roots were then spread out to dry and in eight to twelve days they were ready for the market.

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18. The cultivators either took the crop to the market or retained it till the dyers came asking to be allowed to purchase.

19. Cotton followed *al*, the preparation for the cotton serving to level the field, and *al* usually again followed cotton.

Answers given by cultivators.

Similar answers were obtained from the villagers throughout the *al* country. For example at Sauner **Mr. Raghoba Ratiram**, Vice-President of the Municipality, said that he cultivated his own estate (some 500 acres) and took the greatest possible interest in *al* cultivation. To his personal knowledge the exports of *al* five years ago from Sauner were at least 1,000 *kundis* (say 400,000lb), valued at R4c to R60 a *kundi*; that the seed formerly sold at R80 (large *al*) per *kundi* and R40 (small *al*). The area under the crop around Sauner may have formerly been 2,000 acres. Now there is no cultivation and no demand. He has himself over 100 *kundis* in stock, for which he can find no purchaser. The coolies who, a short time ago, found employment in digging up the crop are at present in extreme poverty, and the dyers of Sauner who formerly used *al* now employ nothing but aniline.

Decline of the industry in Ellichpur.

Ellichpur, once the centre of a great *al*-dyeing industry, cannot boast now-a-days of a single dyer that uses *al*. At Ellichpur are manufactured the peculiar handkerchiefs that are worn by the people of Berar, but until recently the reds in these were *al*, now they are aniline. A slight fall in the price of red dyed cloths has taken place, but this advantage every one admits was by no means compensated for by the loss of the indigenous industry of cultivating the dye stuff. Indeed many persons hold that the Government would confer a positive boon on the people were they to impose a heavy import duty upon these pernicious dyes—dyes that are working disaster in the rural parts of the country.

Early account of Al cultivation—1794.

EARLY ACCOUNT OF "AL" CULTIVATION.

The first historic detailed account of the cultivation of the *al* plant was that given by **William Hunter** in the Asiatic Researches (Volume IV) published in 1794. He there deals with its production in (Malava) Malwa, a province which does not at present cultivate the root to any great extent—at least it is not reported as doing so. Some of **Mr. Hunter's** remarks are peculiarly interesting. He says, for example, that "the flowers appear in June, and the fruit ripens in September or October, but the fruit of those young trees is not used for seed, as it is said not to produce vigorous plants." From that statement it may be inferred that the Malwa crop one hundred years ago all belonged to the *moti al* race, but that the less vigorous *chhoti al* was known, though not appreciated. He then proceeds to say that "as the colouring matter resides chiefly in the bark of the root, the small twigs, which contain little wood, bear a higher price than the larger pieces. Therefore, the roots, when dug up, are separated into three kinds—coarse, medium and fine. The coarse sells for one rupee per *mun*, the medium two or three rupees, and the fine for four rupees per *mun*, or four seers for a rupee. In particular fields they have trees for seed, at the distance of four, five, or six cubits. In six years they yield fertile and vigorous seeds. The trees when

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CULTIVATION.

of that age are about six inches in diameter, twelve feet high (branches included), but they continue fruitful for many years, and are said to grow to a size not much inferior to that of a mango-tree." The further particulars as to method of cultivation, rotation of crops, and preparation of seed are precisely as indicated above in the answers to the questions addressed to the cultivators in Berar. **Mr. Hunter**, in describing the cultivated plant, dwells upon the fact that the leaves of the Malwa plant do not bear out the "similitude" implied by the Linnæan "trivial" name of **citrifolia**. In other words, he noted the change from the broad foliage of the arborescent form to the linear oblong-acute and cuneate leaves of the field plant—the distinction that led **Roxburgh** subsequently to give the name **M. tinctoria** to that condition.

METHODS OF UTILIZING THE DYE.

The article in the Dictionary on the Economic Products gives practically all that need be said on the subject of the Native methods of using *al* dye. On this subject **Mr. William Hunter** wrote in 1794:—

DYEING: Indian Method.

IN CENTRAL INDIA.

"The cloth to be dyed is thoroughly washed and scoured with an extemporaneous kind of soap lie, made by mixing the oil of sesamum with fossile alkali. Then, supposing the cloth (which is generally of a thin texture) to be twenty-six cubits long, and one cubit broad, the quantities of ingredients will be as follows: Take of large *Her** in powder three ounces. Mix it well with four pounds of water. In this the cloth is to be thoroughly wetted, so that the absorption of *her* may be as equal as possible. It is then to be squeezed and spread in the sun for about forty-eight minutes to dry, taking care that no drop of water fall upon it. The cloth, when dried, is of a cream colour. It is kept in this state for four or five days that the particles of the myrobolan may be more firmly attached.

"Then take of the powdered alum two ounces; dissolve it in two pounds of water. Wet the cloth thoroughly and equally in this solution. Wring it and strike it gently on a smooth stone, then spread it for 24 minutes in the sun to dry. When dried it is of a pea-green colour. When perfectly dry, it is kept for four days, and then washed in cold water. To the manner and degree of washing, we are told, great attention is to be paid, as an error, either in excess or defect, would spoil the colour. When washed, it is dried in the sun.

"The cloth, thus prepared, is ready to receive the colour, which is prepared in the following manner: Put 3½ gallons of water into an uncovered copper vessel, and set it on a gentle fire. When it is something more than lukewarm, put in the cloth, along with the colouring ingredients which have previously been thus prepared. Take of *al* from one to two seers, according to its quality, powder it, and rub it with two ounces of oil of sesamum to each seer; add of the flowers of *dhawry*† one-eighth of a seer to each seer of *al*; or, instead of *dhawry*, one ounce and a half of *purwas*‡ in powder. The cloth and colouring ingredients are continued on the fire, with a gentle heat, gradually increased, for

* Terminalia Chebula.

† Woodfordia floribunda: the foot-note to the original explains that these flowers are employed because of their astringent property and not on account of any colour they impart.

‡ Said to be a kind of gall-nut found on an Acacia.—*Ed.*

about three hours. Towards the end the water is made to boil strongly. By taking up a little of the water and examining its colour, as it is dropped in the vessel, they judge of the success of the process. It ought to be of a clay-colour, or a little deeper. If it proves very red, the colour would be spoiled, and the remedy is to add a larger proportion of *dhawry*. During this process the cloth is continually moved, by lifting part of it with a stick out of a vessel, beginning at one end and proceeding to the other. It is now taken out, wrung and dried. After which, being washed in river water, the red colour is complete." DYEING: Indian Method.

"To make a dark purple, or chocolate colour. Take of martial vitriol one ounce, dissolve it in two pounds of water, and clear the solution by decantation. Mix with a quantity of the above-described colouring decoction, sufficient to wet the cloth, such a proportion of this martial solution as will give the tint required." "The cloth, being taken out of the colouring decoction, and wrung, is to be dipped into this mixture, and thoroughly wetted, so as to absorb the colour, equally and completely." "Both of these colours are very durable, being little affected by washing. One of the quarters of Oujein (Ujjain), named Jeysinpoorah, is inhabited by dyers, who consume great quantities of this root. Their printed and stained cloths, besides supplying the domestic consumption, are exported to Guzerat and other provinces."

The large trade to which **Mr. Hunter** alludes as having existed in Ujjain one hundred years ago has practically disappeared, and Guzerat is more likely to export dyed garments to that anciently classical city than to import such goods therefrom. The few passages given above, it is hoped, may prove interesting to many persons who have not the opportunity of consulting the original. As in Ujjain and Ellichpur, so in most of the well-known centres of the *al*-dyeing industry, the contest between this beautiful tinctorial agent and aniline dyes has been more acute than in the less-known localities. Indeed it is in the remoter parts of the country and at a distance from the regions of *al* cultivation that one has now-a-days to look for the old industry. The following interesting account from Kathiawar may, therefore, be regarded in this light. It is the survival of the art in a region that never apparently cultivated the plant and which preserves the tradition to this day that the roots are imported from Malwa. Contest with Aniline.

Account of the country-process of dyeing the cloth with "Al" dye, by MR. M. J. BHARWADA, *Agricultural Assistant, Gondal, Kathiawar.* In KATHIAWAR.

First.—The first process the cloth passes through is that it is dipped in a mixture of sheep-dung and water. For 20lb of the cloth the proportion of sheep-dung used is 2½lb. The sheep-dung is mixed in cool water and is trodden under the feet till the whole is reduced to the form of a liquid state. The cloth is dipped into this mixture, and is allowed to remain in it for at least twelve hours, or one whole night. Next morning it is taken out, rinsed and dried. Sample of cloth No 4996 is the new cloth selected to be dyed. Sample No. 4997 is the cloth passed through this first process.

Second.—The cloth from the first process is dipped in a solution of the country alkali called *khara* (sample of which is separately kept marked No. 5011). The proportion of the alkali used is the same as that of the sheep-dung. It is dissolved in about 5 gallons of warm water, and the cloth is allowed to remain in it for twelve hours. Next morning it is taken out, rinsed

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DYEING: Indian Method.

In KATHIAWAR.

and washed in fresh water and dried. Sample No. 4998 is the cloth treated in this manner.

Third.—The cloth is dipped in a mixture of 2℔ of castor oil, 2℔ of alkali and about 5 gallons of water. It is allowed to remain in this for twelve hours. Next morning it is taken out, rinsed and dried. It is not washed in fresh water. Sample No. 4999 is the cloth passed through this further process.

Fourth.—In order to get rid of the surplus part of the castor oil in the cloth, it is every day washed in fresh water and dried for three consecutive days. Then for the next three days it is every day dipped in a solution of alkali for twelve hours, taken out, rinsed and dried. On the seventh day it is washed in fresh clear water or running stream and dried. Sample No. 5000 is the cloth passed through this process.

Fifth.—The cloth is next dipped in a mixture of 8℔ of the myrabolan powder and 1℔ of gum (samples marked Nos. 5012 to 5014,) with about 8 gallons of water. The cloth is taken out at once after it is dipped, rinsed and dried. Sample No. 5001 is the cloth so treated.

Sixth.—The cloth is again dipped in a mixture of 2½℔ of the myrabolan powder and about 5 gallons of fresh water. It is allowed to remain in it for a short time. Then it is taken out, rinsed and dried. Next it is dipped in a solution of 2½℔ of alum (sample marked No. 5015) in about 5 gallons of water. It is taken out at once after it is plunged, rinsed and well dried. It is then washed in clear water and dried again. Sample No. 5002 is the cloth advanced through this stage.

Now the cloth is ready to receive the *al* dye. But if it is desired to print the cloth before dyeing, it has to pass through some further stages as mentioned below. After the fifth process of myrabolan and gum, it is taken to the following intermediate processes before it is passed through the sixth stage of myrabolan and alum.

1st.—A mixture of 20℔ of castor oil (country), 2½℔ of wax, and 2½℔ of the powder of a vegetable oily substance, known by the name of "khan khan" (samples marked Nos. 5016 and 5017) is made, and the whole thing is heated, till reduced to a liquid condition. The wooden blocks with which the cloth is to be printed are dipped in this warm oily liquid and printed on the cloth as required. After being printed the cloth is dried. Sample No. 5003 is the cloth printed with various designs.

2nd.—Then the printed cloth is dipped in a solution of 1℔ of sulphate of iron (sample marked No. 5018) with about 8 gallons of clear water. The cloth is allowed to remain in this for about half an hour and is then taken out. It is next kept in boiling water for about an hour. This process removes the surplus wax from the printed cloth. The wax collects on the surface of the water and is separated. Sample No. 5004 is the cloth carried up to this stage.

When the cloth has been passed through the processes described in the six preceding paragraphs; it is at first dipped in a mixture of water and myrabolan powder. Sample No. 5005 is the cloth passed through this process; next it is dipped in a solution of alum and dried; after it is well dried, it is washed in clear water and dried again. Sample No. 5006 is the cloth passed through this alum process. The printed cloth is now ready to get dyed.

Seventh.—Lastly, the dyer prepares the *al* dye. For this purpose 30℔ of the fine powder of *al*-roots, 2½℔ of the manufactured (European market) red dye, * and 2℔ of the powder of a mordant (vegetable), called by natives

* Is this aniline? In Ellichpur the writer found the dyers using a mixture of *al* and aniline and saw them passing off the fabrics thus treated as *al* dyed. The addition of even a little *al* gives the peculiar tint of that dye to the coarser and cheaper tinctorial reagent.—*Ed.*

"Padwas," Nos. 5019—5022, are mixed and put in a very big copper pot specially made for this purpose. About 40 gallons of water are added to it. The cloth to be dyed is put in this vessel, and the whole thing is heated under fire for about two hours. While it is being heated, the cloth is now and then stirred with poles. The cloth absorbs the dye within that time, and the liquid appears to be clean. The cloth is then taken out, washed and dried. Sample No. 5007 is the cloth so dyed. Sample No. 5008 is a coarse cloth dyed, and sample No. 5009 is the printed cloth dyed with this dye. If the simple cloth be required to be black-coloured, it is dipped into a solution of sulphate of iron, washed and dried. Sample No. 5010 is the black-coloured cloth.

DYEING: Indian Method.

In KATHIAWAR.

The above is the process of colouring cloths in the *al* dye. These cloths are now used by females for their dresses in this country. Formerly this was the only cloth used by all females, but now-a-days the cloths dyed and prepared in European markets have occupied its place, and the country trade of dyeing is much depressed. Besides which, the native-dyed cloths are used in petty domestic purposes, such as carpets, bed cloths, etc. Cotton twist is also similarly dyed with this dye, and is employed by weavers only.

The *al* plant is neither produced nor cultivated in Kathiawar, but it is imported here from Guzerat and Central India, etc. The samples of the bazar *al*, its powder-manufactured red dye of the European market, and the mordants are sent (marked Nos. 5019 to 5022).

Al was the only dye formerly employed for dyeing purpose. Now-a-days many dyers use the manufactured European red dye* for the *al* dye, and some use both combined in certain proportions. It is said that the European dye gives better colour, but that the cloths dyed with this dye do not last long, and besides that the dyers' copper vessels are easily rusted and worn away by the use of the European dye.

* Aniline.

In place of the sulphate of iron some dyers employ the mineral dye, known as *kayo* or red-ochre. It is powdered and made into balls, which are roasted in the fire. When cool, they are dissolved in water, and this gives a black colour to cloths. This process being rather a complicated one, the sulphate of iron is substituted. The samples of the mineral ochre (marked Nos. 5023 to 5026) are also sent herewith. The refuse part of the mineral dye of red-ochre is much used as a preventive against the attacks of white ants, and is applied to the stems of trees in mixture with aloes asafœtida, castor oil cake, etc.

Conf. with p. 4.

EXAMINATION OF THE DYE BY **Professor Hummel** AND **Mr. Perkin.**

DYEING: European Method.

Hummel & Perkin's experiments.

Such, then, is the complicated process followed in India, for though in various districts it is varied to a considerable extent, the two examples given may be said to fairly represent the indigenous systems of utilizing the dye. The labour entailed may well be supposed, were there no other considerations, to act as an incentive to the substitution of the cheaper and simpler methods necessary with aniline dyes. This being so, more than ordinary interest centres around the chemical investigations recently performed by **Professor Hummel** and **Mr. A. G. Perkin** of the Yorkshire College, Leeds, and which have been published in the Journal of the Society of Chemical Industries. The samples of **Morinda** roots (analysed by these chemists) were furnished by the Reporter on Economic Products through the Imperial Institute, London, and it may be here announced that the results obtained may be regarded as but the first (though an exceedingly important) contribution toward a better knowledge of the subject. **Professor**

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DYEING : European Method.

Hummel & Perkin's experiments.

Hummel and Mr. Perkin have kindly undertaken to continue their investigations in order to solve the practical question of the varying yield of different forms of **Morinda**, of roots from diverse climatic localities, from different systems of cultivation and seasons of collection, the object being to discover, if possible, the most profitable forms of the plant and the regions where encouragement had best be given to foster a revival of the expiring industry. Already these distinguished chemists have prepared the way for a greatly improved system of using the dye principle than that pursued in India And it is to be hoped they may extend an even more direct helping hand to India by designing a simple process, by which the dye in a half state might be prepared ready for export. The hope entertained in India lies more in the direction of organising a new foreign trade than in any very immediate revival of the now almost extinct industry of *al*-dyeing. It will be seen from the passages quoted below from Professor Hummel and Mr. Perkin's paper that these chemists have most undoubtedly made an advance in that direction by the improvement they have shown to take place through a process of simply steeping and washing the roots. In their report on **Morinda** they begin by reviewing all previous publications, and in this part of their paper they trace the European knowledge of the dye from the investigations made by Dr. Bancroft about the year 1790—

Bancroft's Results: 1790.

"On calico printed with alumina and iron mordants, separately or mixed, Dr. Bancroft is said to have obtained reds, purples, and chocolates, very similar to the analogous madder colours, and equally durable. At the same time he considered that it might be profitably imported into Europe, and that it possessed the advantage over chay-root, that it was less liable to deterioration during storage.

Schwartz & Koechlin: 1832.

In 1832 Schwartz and Koechlin also examined this root, under the names *Nona* and *Hachrout*,* and reported on its dyeing properties to the Industrial Society of Mulhouse, in the paper already alluded to under chay-root. They pointed out its extreme toughness as compared with madder, and hence the greater difficulty experienced in grinding it. They referred also to the fact that of all the Indian Rubiaceæ examined by them it contained the largest quantity of certain yellow principles of an acid character, which not only necessitated the washing of the root with cold water before dyeing, but also made it requisite to add a certain proportion of carbonate of soda to the dye bath in order to have a perfectly neutral bath, and to the neglect of this precaution they ascribed the indifferent results obtained by others. They recommended that the root be dried at a low temperature, then ground as finely as possible and washed with fifty times its weight of pure cold water, filtering the mixture, and pouring fresh water over the root collected upon the filter.

Washing the powdered Root.

To the dye-bath they added one fifth of the weight of the root of carbonate of soda, and having introduced the mordanted material, the temperature was raised gradually to the boiling point. In this manner they were able to obtain on oil and alumina mordanted calico a very full red, which on clearing in the usual manner with soap and stannous chloride, changed to a scarlet, resembling the Turkey-red obtained from madder. On ordinary calico printed with iron and alumina mordants they obtained black, lilac, red, and chocolate, differing only from the analogous madder colours by having a much yellower tone. All the colours stood soaping very well, still preserving their yellow tone, the lilac alone being deficient in brilliancy.

* Ach-root.—*Ed.*

DYEING: European Method.

Their conclusion was that, since morinda-root only possessed one-third the dyeing power of a medium quality of madder, it could never compete with the latter in the European market.

Anderson: 1848.

At a later date, about the year 1848, some morinda-root was imported into Glasgow under the name of *Soorangee*, with the intention of introducing it as a substitute for madder. It was submitted for trial to some of the most experienced and skilful calico-printers of the district, all of whom concurred in declaring it not to be a dye at all, and to be totally destitute of useful applications. Professor Anderson, of the Glasgow University, hearing of this circumstance, obtained a supply of the root, submitted it to a chemical examination, and succeeded in isolating from it a yellow crystalline product. Anderson found that this substance did not dye iron and alumina mordants printed and fixed on calico as usual with calico-printers, but cotton prepared with oil and mordanted with alumina as for Turkey-red assumed a dark brownish-red colour, devoid of beauty. The absence of dyeing properties in this *morindine* is readily explained, *for we now know it to be a glucoside*. When submitted to dry distillation, Anderson found morindine to yield an orange crystalline sublimate which he called *morindone*, and this same substance was also produced by boiling morindine with dilute mineral acids. *Morindone* represents the true colouring matter of morinda-root, and accordingly Anderson found it to dye ordinary mordanted calico in the normal manner.

Roch leder: 1852.

In 1852 Rochleder gave it as his opinion that morindine and morindone were identical with the ruberythric acid and alizarin derived from madder. That this was not the case was first adduced by Stein (*J. Pr. Chem.* 97, *234*), and in 1887-88 Thorpe, in conjunction with Greenall & Smith (*Jour. Chem. Soc.* 52, *52 and* 53, *171*), showed conclusively the correctness of Stein's view, and further that the constitution of morindine corresponded to a *tri-hydroxy-methyl-anthraquinone*, alizarine being, as is well known, a *di-hydroxy-anthraquinone*.

Principle involved in Morinda dyeing.

Experimental Results.—Having regard, therefore, to the extensive employment of **morinda**-root as a red dye-stuff by the Natives of India, and the undoubted difficulties experienced by many European experts who have in the past attempted to apply it for the production of reds, our attention and interest was attracted to this dye-stuff with the view of determining the best method of applying it successfully.

Further, although **morinda**-root has already been examined by several chemists and the nature of its chief colouring principle has been established, it seemed desirable to determine the character of those accompanying principles analogous to the yellow substances found in madder, chay-root, and munjeet, which from its botanical relationship it might naturally be expected to contain.

With respect to this part of our examination the results will be communicated at an early date to the Chemical Society, but it may already here be stated that several of the above-mentioned yellow substances have been isolated in the crystalline condition. As to the essential colouring principle it is found to be present almost entirely in the form of the glucoside morindine which in the pure condition proves to be of a somewhat stable character.

Now it is well known that the colouring matter of the madder-root is there present also largely as the glucoside ruberythric acid, a substance devoid of dyeing properties with respect to mordants, although it will dye wool and silk a bright yellow colour. Moreover, it is a matter of common

DYEING: European Method.

knowledge, thanks to the researches of Schunck, that the madder glucoside is split up under the influence of acids, alkalis, and ferments into glucose and the useful colouring matter alizarin.

In attempting, therefore, to solve the mystery connected with the successful application of morinda-root in dyeing, our first endeavours were directed to the splitting up of the glucoside of the root by one or other of the methods indicated as effectual in the case of madder.

Reduction of the Glucoside by Fermentation,

Fermentation experiments were made with several weighed quantities of ground **morinda**-root. In one case, presuming some ferment might be naturally present in the root, 60 grms. of root were merely mixed with 700 cc. distilled water and left to stand for five days at a temperature of 35° C. A similar experiment was made with the addition of chalk sufficient to neutralise the natural acidity of the root. Other experiments similar to these were carried on simultaneously with the addition of a small percentage of ground madder-root, on account of its ferment; yeast was also tried. In all cases fermentation took place, and the mixtures were thrown on calico filters, drained and washed rapidly with four litres distilled water. The fermented roots were dried at a low temperature, and the loss of weight (14—17 per cent.) determined.

Eventually pieces of calico printed in stripes with alumina and iron mordants were dyed with equivalent amounts of the various fermented root and the root in its original condition. The latter scarcely dyed at all, whereas the fermented roots gave fairly good reds, chocolates, and lilacs similar to the analogous madder colours. The root fermented with yeast gave the best result. In all cases the addition of chalk to the fermenting mixture was injurious. It was evident, therefore, that a considerable improvement in the dyeing power of the root had been effected, either by the fermentation or by the washing, but since better results were obtained by other methods carried on at the same time, the fermentation experiments were not continued.

by Alkalis,

To effect the decomposition of the glucoside by means of alkalis, barium hydrate was selected, for in the course of the purely chemical examination of the root it was found that not only could the glucoside morindine be split up by this agent, but the morindine produced, formed an insoluble lime compound, whereas the accompanying yellow substances formed soluble compounds. By boiling **morinda**-root, therefore, with lime-water and then washing, the whole of the yellow substances could be removed, and by a subsequent treatment of the residual root with acid and washing the calcium compound of the morindine could be decomposed and the lime removed, leaving behind a purified root containing only morindine in the free state.

For some reason or other the **morinda**-root treated in the above-mentioned manner yielded only indifferent results in dyeing, and having regard to the number of operations required and the better results otherwise obtained in a simpler manner, the matter was not further inquired into.

by Acids,

Decomposition of the glucoside by acids resolved itself into the preparation of a garancine from **morinda**-root, and this was done not only with the root in its natural condition, but after it had been thrice washed for two hours with ten times its weight of water, since this is a usual preliminary process in the manufacture of ordinary garancine from madder. One hundred grms. ground **morinda**-root was boiled six hours with three litres water, containing 15 cc. ordinary sulphuric acid, then allowed to cool, collected on a filter and washed with cold water until thoroughly free from acid, and dried. The product obtained, amounting to 37·5 grms., had a very dark green, almost black colour in the case of the unwashed

root, due to the presence in it of chlororubine; the washed root gave 37·7 grms. of a paler green product.

On dyeing stripe-mordanted calico with *morinda-garancine*, with the addition of 2—4 per cent. of its weight of calcium acetate, good colours were obtained.

DYEING: European Method. Reduction of the Glucoside by Washing.

One other method of improving the dyeing power of **morinda**-root, also borrowed from the madder industry, still remained to be tried. Many years ago immense quantities of the so-called "flowers of madder" were made in France by simply mixing ground madder with about 10 times its bulk of water, allowing the mixture to stand 12—15 hours, and finally filtering, pressing, drying, and grinding the product. Although, no doubt, some fermentation and consequent decomposition of the glucoside took place during the steeping, it has usually been regarded as a mere washing process, whereby certain soluble matters, especially acids like pectic acid, etc., were removed and thus prevented from soiling the dyed colours and the unmordanted parts of calico-prints (the so-called "whites"), and also from impoverishing the colours by dissolving off some of the mordant. The loss in weight experienced amounted to 55—60 per cent., *and corresponding to this the dyeing power was about doubled.*

In imitation of the foregoing process, then, 300 grms. ground morinda-root were mixed with three litres distilled water and allowed to stand, with occasional stirring, for two hours; the mixture was then filtered through calico, and the residue was similarly treated a second and a third time, the last steeping being prolonged to 21 hours. The waste liquors were perfectly clear and of a dark olive-yellow colour. These liquors were subsequently boiled for three hours, with the addition of a little sulphuric acid, when a copious dark-green precipitate, chiefly composed of chlororubin, was obtained. This precipitate was collected, washed free from acid, and its colouring power, as determined by comparative dyeing experiments, proved to be equal to 4 per cent. of that of the washed root after drying. In similar experiments with other samples of **morinda**-root the precipitates showed no dyeing power whatever.

It may be considered, therefore, that little or no useful colouring matter is removed by this washing process; on the other hand, dyeing experiments made with the washed and dried root showed that, whereas in its original state it was quite useless as a dye-stuff, it had now acquired the property of dyeing mordanted calico to a very marked and useful extent.

Re-agents necessary to strengthen the colour. Chalk: Sodium & Calcium Carbonate & Acetate.

Its colouring power was, however, not fully developed until such salts as sodium carbonate or acetate, calcium carbonate or acetate, had been added to the dye-bath. Similar additions, especially chalk, are usual in the case of madder grown on a non-calcareous soil, and the yellow colour of **morinda**-root, both before and after washing, evidently indicate that its colouring principle is in the free state, rather than combined with mineral matter, *e. g.*, with lime, etc. We may add that the chemical examination corroborates this view. On comparing the relative advantages of the above-mentioned salts, it was found that in each case their addition to the dye-bath was decidedly beneficial. The following are the amounts we found it necessary to employ to give the best results: 1·5 per cent. sodium carbonate (10 aq.), 1 per cent. chalk, 16 per cent. calcium acetate, 16 per cent. sodium acetate. Chalk, and especially sodium carbonate, may be regarded as the best additions, but excess of either of them is far more injurious than in the case of calcium and sodium acetate, whose effect is very much weaker, as shown by the large amounts it is necessary to employ.

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DYEING: European Method.

No doubt these proportions would have to be varied a little, according to the quality of the root, and the method of the washing process employed.

As to the actual dyeing process, it differs in nowise from that in vogue with madder. The mordanted calico was always introduced into the cold dye-bath, the temperature of which was then gradually raised to the boiling point in the course of 1½ hours, and the dyeing continued for half an hour longer. The usual subsequent treatment of the dyed patterns with hot or boiling soap solutions sufficed to clear the whites and brighten the colours. In order to gain some idea of the amount of colouring matter in **morinda**-root and **morinda**-garancine, comparative dyeing experiments on stripe-mordanted calico were made with pure morindone, from which it appeared that the particular **morinda**-root examined contained the equivalent of 1 per cent. morindone; 7·5 grms. washed **morinda**-root (equivalent to 10 grms. of the unwashed root), had a dyeing power equal to 15 grms. madder root of good quality.

Reds & Pinks with Alumina.

The red and pink obtained on alumina mordant are yellower than the corresponding madder colours, the chocolate presents a similar difference in tone, and hence appears fuller than a madder chocolate, while the lilac is distinctly redder.

Oil-prepared Calico.

Oil-prepared calico mordanted with alumina as for Turkey-red gives a very bright orange-red or scarlet, similar in shade to that given by flavo-purpurin, and fast to clearing with soap and stannous chloride. Chromium mordant on similarly prepared calico gives a full rich chocolate, and iron mordant yields colours varying from dull purple to black according to the intensity of the mordant.

Wool & Silk.

On wool and silk, mordanted according to the usual methods, good chocolate-browns are obtained with chromium, orange-reds with alumina, bright orange with tin, and dark purple and black with iron mordant.

Washing Process.

All the colours referred to are as fast to soap as the corresponding madder colours; their fastness to light has not yet been studied, but we shall not be surprised to find them equal the madder colours also in this respect.

Dyeing-power of Morinda.

Although, as already stated, *unwashed* **morinda**-root will not dye ordinary mordanted calico, it does dye, to a small extent, with sodium carbonate added to the dye-bath, cotton prepared with oil and alumina mordant as for Turkey-red; but even here the orange-red colour produced is very weak compared with that obtained by means of the *washed* root. With respect to wool and silk, however, even in the unmordanted condition, these fibres may be readily dyed both with the washed and unwashed root more or less rich yellow and orange colours, the brightness of which is enhanced by maintaining the dye-bath in a slightly acid condition through the addition of a little acetic acid. Parallel experiments made with solutions of crude chlororubin and of pure morindine showed that the former gave a weak olive-yellow, the latter a bright-yellow colour inclining to orange or even red if the bath becomes neutral or alkaline. It seems evident therefore that the orange and yellow colours obtained by T. Wardle are merely due to the glucoside morindine naturally present in the root, and since they are of a sensitive character towards alkalis, being turned red thereby, and are probably fugitive towards light, they are not likely to prove useful colours. It may be added that the ruberythric acid of madder possesses similar properties as a direct yellow dye for silk and wood.

Conf. with p. 9.

Simple Method.

Having then in the above-mentioned washing process found a simple and ready means of rendering the **morinda** root of Indian commerce a really useful dye-stuff, we compared the colouring power of the following

and of the growers of *Al*-root. (*Hummel & Perkin.*) **MORINDA umbellata.**

nine different samples of root supplied to us by the authorities of the Imperial Institute, London :— **DYEING : European Method.**

1	Root, thin, Damoh, C.P.	.	1313/92
2	„ „ „ „	.	1315/92
3	„ middling, Damoh, C.P.	.	1312/92
4	„ „ „ „	.	1314/92
5	„ first quality, Jhansi District, N.-W.P.	.	338/92
6	„ middling „ „	.	384/92
7	„ powdered „ „	.	349/92
8	„ „ „ „	.	290/92
9	„ medium thickness, Jalaun „	.	343/92

Comparative Tests.

Roughly speaking, 1lb of Nos. 1, 3, 7, containing the equivalent of 1 per cent. morindine, and quite equal to good madder, had the same dyeing power as 1½lb of Nos. 5, 2, 4, and as 3lb of Nos. 6 and 9. No. 8 was very poor indeed, and seemed to have been spoiled. All the above roots in their washed and dried condition had a more or less bright olive-yellow colour, except No. 8, which was decidedly brown.

The results of the foregoing experiments entirely corroborate those obtained by Schwartz & Koechlin as to the necessity of washing the finely ground roots with water before dyeing, and the addition of an alkaline salt, chalk, or carbonate of soda, to the dye-bath in definite proportion, if good full rich reds, etc., are to be obtained. We never found it necessary, however, indeed it would have been injurious, to add to the dye-bath such a large proportion of sodium carbonate as 20 per cent. of the weight of the root. This difference is probably owing to the different method of washing adopted. Schwartz & Koechlin seem to have washed the root with a much larger quantity of water than we did, but for a short period only, indeed without any steeping at all apparently, whereas *we steeped the ground root in three successive quantities of water for a total period of 25 or even 50 hours*, and always with beneficial results. The comparatively slight solubility of the glucoside permits indeed of considerable washing of the root without entailing any material loss of colouring power, and it seems to us best to prolong the washing a little in order to escape the necessity of adding large percentages of chalk or sodium carbonate to the dye-bath; excessive washing, however, must of course be avoided, otherwise loss of dyeing power would ensue through loss of morindine.

Washing Process: Steeping essential.

One interesting feature in connection with morinda dyeing is, that although the washed root undoubtedly contains the colouring principle still in the form of the glucoside, and which is of marked stability, it nevertheless dyes extremely well. We are unable at present to explain this, and are inclined to think that the presence of the mordant on the fabric has some influence in the matter, although we have had no time as yet to study this point."

In another part of their report **Professor Hummel** and **Mr. Perkin** deal with the subject of the *Mang-kudu* dye **(Morinda umbellata)** which is employed in Java in giving the red shades to their *batick* calicos. In India this form of *al* is used to a very small extent, but at the present moment fresh enquiries are being made in the localities where the plant occurs. It may, therefore, serve a useful purpose to review here very briefly the chief peculiarities of this dye that have a practical bearing. In a subsequent paper on the chemistry of *mang-kudu*, these distinguished investigators have isolated the leading com-

MORINDA umbellata. **Present condition of the *Al*-dyers**

pounds found and given their formula. It contains, like chay-root, but a single colouring matter, though in most of its characteristics *mang-kudu* resembles madder more nearly than chay-root.

"There are present, however, though only in small quantity, numerous yellow, crystalline substances, totally distinct from those found in chay-root, and, judging from their behaviour, more nearly allied to those isolated by Schunck from madder."

"Our experiments in dyeing show that wool and silk when boiled with a decoction of *mang-kudu*, with the addition of a little acetic acid, acquire more or less rich orange and yellow colours, due to the morindine, but these are of little or no value, as they are at once turned red by alkalis.

"On mordanted cotton it is also practically impossible to obtain any useful result so long as the dye-stuff is applied in its ordinary condition. If, however, the ground *mang-kudu* is washed by steeping it in ten times its weight of cold water for two or three hours then collected, and this treatment repeated two or three times, its dyeing properties are unmasked and rendered normal. By this treatment, the root, like madder and chay-root, loses about 70 per cent. of its weight, there being removed saline matter, free acid, chlorogenin, the so-called pectic matter, and a large quantity of certain substances about which little is known, but which, probably, are of a sugary or gummy nature. Whether one or all of these interfere with the dyeing operation has not as yet been determined. It is probable that most of them exert a more or less deleterious influence.

"After this preliminary washing treatment, *mang-kudu* may be applied in silk, wool, and cotton dyeing, exactly in the same way as madder, it being merely desirable to add to the dye-bath 1—1·5 per cent. sodium carbonate or chalk, in order to obtain darker or fuller colours. On stripe-printed calico containing the usual aluminium and iron mordants, it gives colours fast to soap and generally similar in appearance to those obtained by the use of madder; the reds and pinks appear yellower, the lilacs darker and redder in hue, and the chocolates darker and duller than the corresponding madder colours. On Turkey-red oil-prepared calico, it gives with aluminium mordant a bright orange-red or scarlet, with chromium a full rich chocolate, and, with iron, colours ranging from dull purple to black. On wool and silk mordanted according to the usual methods, it gives a good chocolate-brown with chromium, orange-red with aluminium, bright orange with tin, and dark purple or black with iron.

"All these colours are fast to the operations of soaping, milling, and scouring, and with respect to the action of light, their behaviour towards it is now being tested; we shall not be surprised, however, to find that they are quite equal to the madder colours in this respect. In conclusion we may say that the dyeing properties of *mang-kudu* are practically identical with those of morinda-root, with which it is so closely related both botanically and chemically."

CONCLUSION.

Conclusion.

As in ordinary **Morinda** it would thus appear that with *mang-kudu* also, a process of steeping and washing suffices to remove about 70 per cent. of the weight of the crude dye-stuff and reduces

CONCLUSION.

the remainder to a stable form insoluble, but which, in contact with the mordants, or in conjunction with certain simple substances, such as chalk, may be immediately absorbed by cotton, wool or silk. Here then **Professor Hummel** and **Mr. Perkin** have placed within the reach of the Indian dyers an inexpensive process of simplifying the use of *al* dye, while they have afforded the key to the production of a dye-material that might be readily exported and which would appear to have a fair chance, if landed in Europe at a cheap rate, of finding an immediate demand. It is, however, unfortunately only too true that, as stated by **Sir. F. Abel** in the letter forwarding **Professor Hummel** and **Mr. Perkin's** report, "much advance has recently been made in the elaboration of fast alizarin colours, of which an extended series now exists." If the anticipations of a trade in a prepared dye-stuff prove well founded, India might still entertain expectations of a recovery of her lost trade in *al* dye. The botanical considerations advanced by the writer would accordingly seem to call for some immediate action, since it has now been shown that the superior roots are not merely, as has been said, the selected finer rootlets, but are the roots of a special cultivated biennial stock—a field crop produced by centuries of selection, the seed of which there is every chance may be lost by the neglect into which the industry is rapidly falling.

CALCUTTA;
February 1895.

G. I. C. P. O.—No. 1252 R. & A. D.—5-9-95.—2,200.

PLATE 1.
(SEE PAGES 5,7)

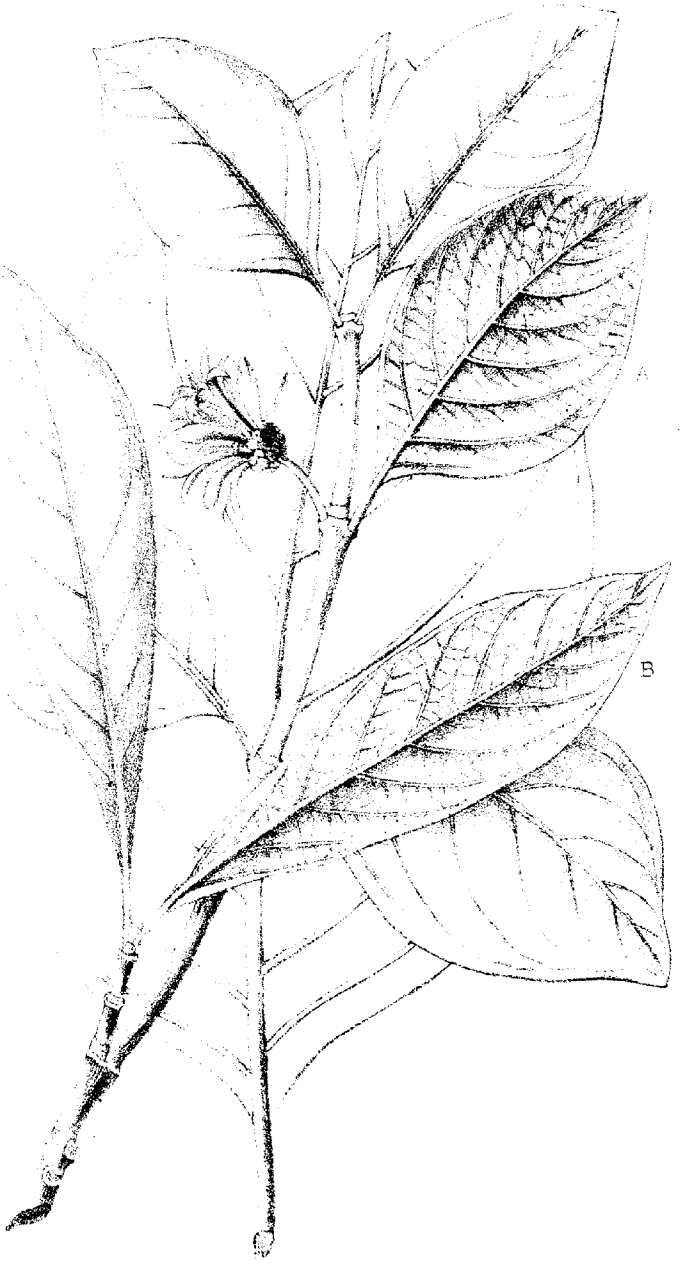
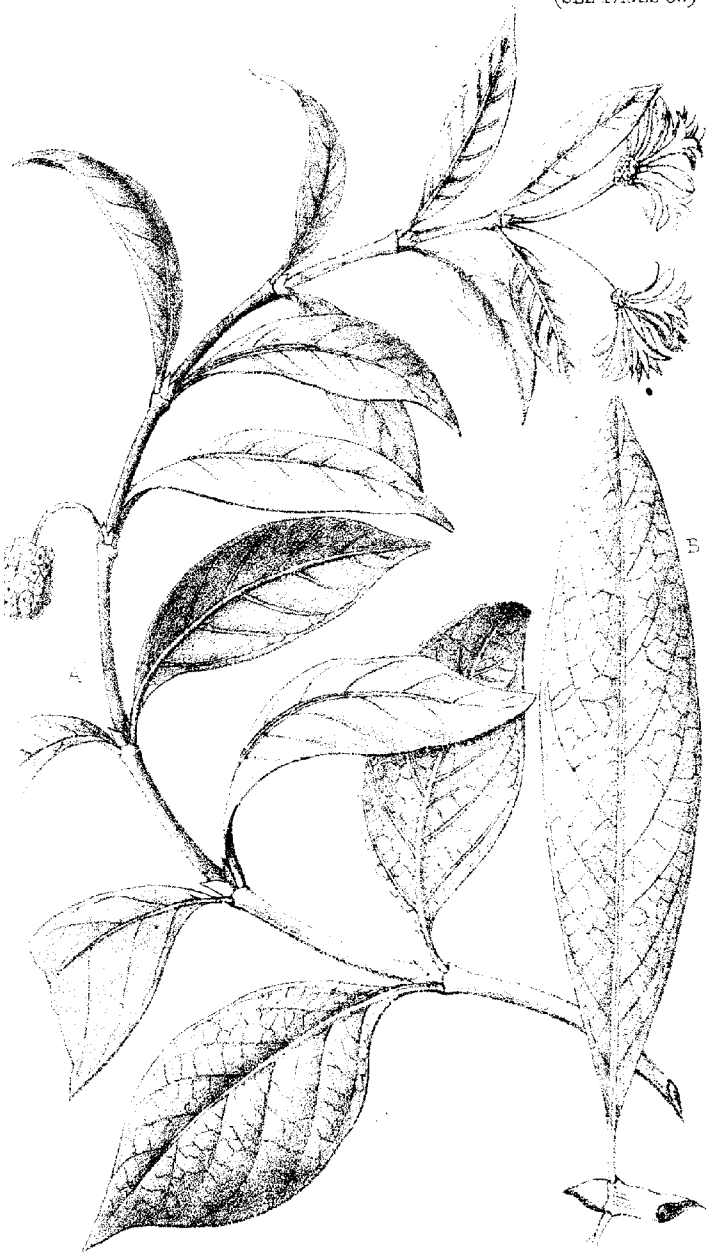


PLATE 2.
(SEE PAGES 6.7)



All communications regarding THE AGRICULTURAL LEDGER should be addressed to the Editor, Dr. George Watt, Reporter on Economic Products to the Government of India, Calcutta.

The objects of this publication (as already stated) are to gradually develop and perfect our knowledge of Indian Agricultural and Economic questions. Contributions or corrections and additions will therefore be most welcome.

In order to preserve a necessary relation to the various Departments of Government, contributions will be classified and numbered under certain series. Thus, for example, papers on Veterinary subjects will be registered under the Veterinary Series. Those of more direct Agricultural or Industrial interest will be grouped according as the products dealt with belong to the Vegetable or Animal Kingdom. In a like manner, contributions on Mineral and Metallic subjects will be registered under the Mineral Series.

This sheet and the title-page may be removed when the subject-matter is filed in its proper place, according to the letter and number shown at the bottom of each page.

(Veterinary Series, No. 11.)

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1895—No. 10.

OXEN AND BUFFALOES.

[*DICTIONARY OF ECONOMIC PRODUCTS, Vol. V., O. 551–94.*]

THE CATTLE AND BUFFALOES OF BURMA.

Note by VETERINARY CAPTAIN G. H. EVANS, A.V.D., *Superintendent, Civil Veterinary Department.*

Other PAPERS that may be consulted:

Agricultural Ledger No. 19 of 1893.
Ditto No. 14 of 1894.
Ditto No. 7 of 1895.

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